Landsat DATA USERS NOTES

ISSUE NO. 25 DECEMBER 1982

NOAA: NEW SPONSOR FOR THE LANDSAT "NOTES"

On January 31, 1983, just a few weeks from now, the U.S. Department of Commerce's National Oceanic and Atmospheric Administration (NOAA) will become the manager of all U.S. civil operational Earth remote sensing satellite activities. This includes the Landsat system, and it culminates a 3-year planning effort that started with a Presidential Directive in 1979.

The **Landsat Data Users NOTES** is part of this transition.

A redesigned format and new masthead reflecting NOAA sponsorship have given the NOTES a new look, and, with this issue, a quarterly publication schedule is being initiated. Work is currently in progress to merge the NOTES mailing list with that maintained by NOAA for its "Satellite Data Users Bulletin." In addition, the scope of the articles will be broadened to include more items of interest to the general remote sensing community, although the primary focus will remain on Landsat, as it has in the past.

Subscription service is available at no charge to interested individuals and organizations anywhere in the world. Those wishing to receive the NOTES may contact:

NOAA Landsat Customer Services
EROS Data Center
Sioux Falls, South Dakota 57198
U.S.A.
Telephone: (605) 594-6151
FTS: 784-7151

Comments, corrections, and queries of any kind may be directed to:

The Editor
Landsat Data Users NOTES
EROS Data Center
Sioux Falls, South Dakota 57198
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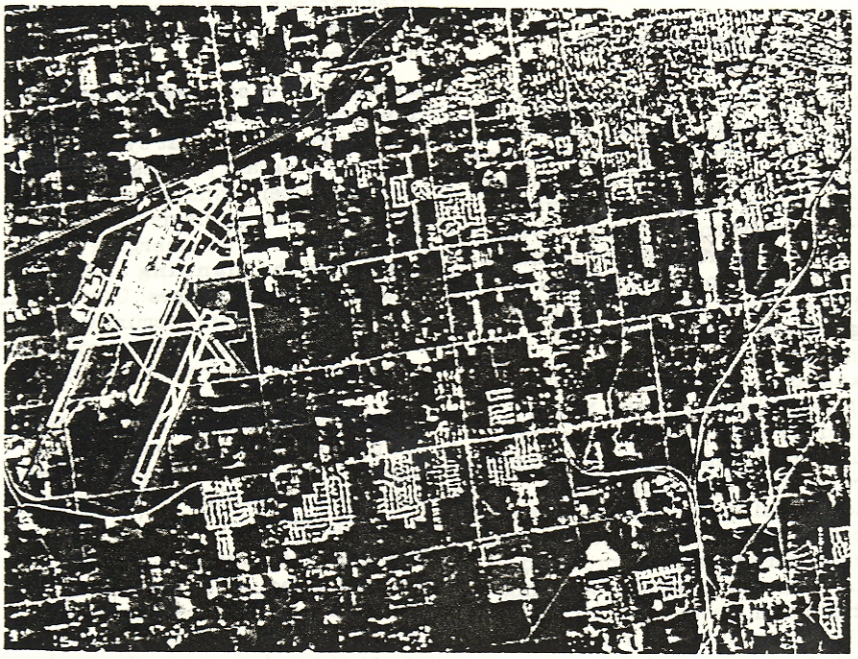
Telephone: (605) 594-6171
FTS: 784-7171



SPECIAL.....

This issue contains a special two-page display comparing thematic mapper (TM) images with those of other Landsat sensors. Turn to pages 6 and 7 for a look at some new data side-by-side with the old.

INSIDE:

NOAA'S OPERATIONAL LANDSAT PROGRAM

Single-Agency Management

Responsiveness to users has shaped NOAA's environmental satellite programs in the past and will be evident in its implementation of the operational Landsat system this coming January. Users will be provided advance information about the routine data collection objectives of the system as well as the data processing and product delivery schedules that NOAA will follow. Those with non-routine data requirements will have the option of requesting the acquisition of particular Landsat scenes. As the single manager of the operational Landsat system, NOAA will be responsible for spacecraft control and scheduling, data processing, product generation, and customer support. Customers will therefore be able to direct their Landsat inquiries and comments to a single agency, and NOAA, with end-to-end responsibility, will in turn be able to adjust the system for best performance on behalf of its customers.

Data Continuity

Landsat 4, launched in July 1982 and now undergoing certification by NASA, will constitute the space segment of the system until it fails in orbit. At that time, Landsat D' will be called up for replacement launch. Each spacecraft has a projected lifetime of 3 years, making data continuity through 1988 possible. Both

are equipped with a multispectral scanner (MSS) sensor as well as a thematic mapper (TM) instrument. The proven MSS will be the initial operational sensor. The experimental TM is scheduled to become operational on January 31, 1985, following a period during which NASA will qualify this new instrument and install a new TM ground processing system.

MSS Product Delivery

The MSS preprocessing ground system at the Goddard Space Flight Center in Greenbelt, Md., provides 48-hour turnaround of newly received MSS scene data. MSS final data product generation will be performed at the Earth Resources Observation Systems (EROS) Data Center in Sioux Falls, S. Dak., and will take an additional 10 to 25 days depending on the product ordered. Computer-compatible tape (CCT) digital products will be available earlier than image products, with color composite imagery requiring the longest generation and product creation times.

MSS Data Collection Precedence

Sites of episodic events or natural disasters that are observable with the MSS sensor will receive first priority when scene collections are being scheduled. Second priority will be given to collecting MSS scenes which customers have requested under the **special acquisition** ordering program and for which they have paid an additional system access fee. Remaining MSS ground system capacity will be used to process scenes that are included in the **MSS Basic Data Set,** a published schedule of generally useful MSS acquisitions which will be collected on a "best-effort" basis. (The MSS Basic Data Set is the subject of an article appearing elsewhere in this issue.)

During the first year, NOAA will process 136 scenes per day through the MSS ground system; of these, 60 to 65 scenes per day will constitute Basic Data Set acquisitions. All scenes processed and meeting established quality standards will be placed in the Landsat archive at the EROS Data Center, and products derived from them will be available for public purchase.

NOAA is already providing for direct readout of Landsat data to ground stations operated by non-U.S. government agencies that have agreements with NOAA. The data acquired by these stations will also be available for public distribution.

Program Objectives

Contributing to the achievement of national objectives is an important aspect of NOAA's space program. Increasing benefits to mankind, fostering space cooperation among nations, and providing opportunities for the private sector to assume increased responsibility in space remote sensing and its applications are among these. In the case of the U.S. civil land remote sensing activity, a specific goal is its eventual operation by the private sector under U.S. government authorization.

Discussions regarding the private sector's involvement in land remote sensing space activities continue, and some private efforts are underway that may lead to relatively early marketplace entries. However, a major consideration of potential private investors remains the size, value, and stability of the market for any data products and services they would choose to offer. In the interim, before a significant private sector venture does begin, NOAA's policy is to help in any way it can to resolve these questions. Providing the data continuity needed to aid in stabilizing and consolidating the market, and allowing market expansion to continue at a natural rate, will be two ways in which this objective will be met. In addition, the new NOAA prices for Landsat products and services that went into effect on October 1, 1982, are expected to provide a better measure of the overall value of these data in an operational setting■

NOAA'S TRANSITION ACTIVITIES

In 1980, NOAA initiated an information exchange program aimed at keeping the user community informed of NOAA's Landsat activities. Advice from industry, academia, individual users, and government at all levels was openly solicited. Wide dissemination of the opinions received, as well as the results of NOAA's own planning process, was made in many different forums.

Landsat issues at the Federal policy level were handled by the NOAA-chaired, 11-agency Interim Policy Group, now formalized as the Program Board on Civil Operational Land Remote Sensing from Space. These agencies and others representing the Federal user community provided NOAA with many details regarding their program needs through FY 1984 and helped establish the interim policies that were needed to move toward a smooth transition of managerial responsibility for the system.

At the same time, NOAA began hosting a series of meetings around the country designed to solicit inputs from the broader, non-Federal Landsat community. Ten of these meetings were held from 1980 to 1981, and six more took place in the first seven months of this year. Attendees have represented the interests of academic institutions, industry, State and local governments, non-profit private organizations, foreign government agencies, and individuals at large. NOAA invited written comments at each of these meetings and used the information it received to guide its decisions in several important areas.

The primary concerns expressed to NOAA by Landsat users during the past two years have been related to:

Data Continuity: Uninterrupted Landsat data flow is the user's first priority. MSS data or data that can be directly compared to historic MSS data are desired.

Improved MSS product delivery: More rapid and more reliable product delivery is regarded as essential by current users and critical to the process of attracting new users.

Reasonable product prices: Users accept the idea of product pricing designed to recover system operating and maintenance costs, but remain apprehensive that very high prices will be established. Most regard cost increase factors of four or five times the 1981 prices to be the upper limit their operations can tolerate. Universities and non-profit training institutions are particularly sensitive to price increases.

A steady flow of program information from NOAA: Users want to be kept advised of Landsat system planning and program progress in order to keep their operations in balance with the operational implementation and to offer their views on emerging plans.

A voice in the planning and implementation processes: Users want a continuously active forum wherein non-Federal concerns can be routinely expressed and assured of consideration.

The successful launch of Landsat 4 on July 16, 1982, has resolved the user community's immediate concern about data continuity. Regarding the other concerns:

MSS product delivery: NOAA's announced schedule for processing new MSS data calls for products to be generated within 12 to 27 days of receipt of the data at the Goddard Space Flight Center, depending on product type.

MSS product prices: Operating and maintenance cost recovery prices averaging 2.7 times current prices

have been announced and put into effect.

Program information availability: NOAA continues to provide program information through mailings, public meetings, conference presentations, news releases, specialized publications, and individual contacts.

Non-Federal voice in Landsat matters: A Land Remote Sensing Satellite Advisory Committee, with a non-Federal membership appointed by the Secretary of Commerce, has been established. It is providing advice on the management of the system and on commercialization and related issues.

Much remains to be done, and individuals and organizations from the Federal and non-Federal sectors alike are continuing to articulate their concerns and recommendations to NOAA regarding its management of the Landsat program. While unanimity of opinion is rare, NOAA does feel that reasonable levels of agreement are being achieved.

A series of public meetings is planned during 1983 at which TM scene collection scheduling, the commercialization issue, TM pricing policy, and other matters of concern to the Landsat user community will be aired for discussion. Anyone having an active interest in the current program, or ideas to share, should plan on attending■

THE MSS BASIC DATA SET

The MSS Basic Data Set is to consist of those MSS scenes that will be the routine data collection objective of NOAA's operational Landsat MSS system. These scenes will be identified, on a published list, by geographic location and scheduled time of acquisition. NOAA will then make a "best effort" to acquire the data and place them in the Landsat archive where they will be available at regular prices.

Beginning on January 31, 1983, and for the remainder of the fiscal year (through September 1983), the Landsat 4 preprocessing facility at the Goddard Space Flight Center will produce 136 MSS scenes per day. About half of this capacity is expected to be used for Basic Data Set acquisitions. This will ensure that any higher-priority data can be processed along with Basic Data Set data without exceeding the planned capacity of the system.

Attendees at the public meetings hosted by NOAA earlier this year were provided with information regarding processing capacity and options for alternative data collection schemes for the Basic Data Set. They were asked to discuss and recommend areas that should be included in the Basic Data Set and to advise NOAA of any apparent oversight of important applications, science, or humanitarian data requirements.

In addition to the verbal comments received at these meetings, 55 letters were sent to NOAA by users commenting on the construction of the Basic Data Set and other issues. Many of these letters were specific in regard to Landsat 4 coverage of the United States. A limited number of letters also dealt with foreign coverage needs. From these commentaries, a general pattern of U.S. coverage needs was inferred, as follows:

Agricultural areas: repetitive 16-day coverage during the growing season.
Forested areas: seasonal coverage.
Mountain ranges: seasonal coverage with repetitive coverage during winter to assess snowpack.
Rangelands: seasonal coverage.
Deserts: biannual coverage.

In order to accommodate these needs, NOAA plans to focus the Basic Data Set on the acquisition of good quality data as follows:

- Cover the entire United States (including Alaska, Hawaii, and Puerto Rico) every 16 days. An attempt will be made to conserve preprocessing capacity by identifying and eliminating those scenes heavily obscured by clouds.
- Concentrate on the establishment of an MSS worldwide data set. This will be accomplished by scheduling MSS coverage of the world's remaining land masses once a year, with minimum cloud cover.

Procedures for implementing the worldwide data acquisition plan are currently being developed. Worldwide climate zones, and their associated vegetation types, are being considered in establishing coverage patterns. Scheduling will also have to be accomplished within sensor and spacecraft operational constraints. The worldwide coverage scheme and coverage of Hawaii will be dependent upon the availability of the Tracking and Data Relay Satellite System (TDRSS) scheduled for launch in 1983.

A draft of the Basic Data Set implementation plan is to be available for distribution to users before the end of this year. After consideration of user response to this document, a proposed MSS Basic Data Set description will be provided to the Program Board on Civil Operational Land Remote Sensing from Space (representing Federal users) and the Land Remote Sensing Satellite Advisory Committee (representing non-Federal users) for review. The approved version will be announced publicly in January 1983.

Recommendations for revisions to the MSS Basic Data Set, once it has been established, are expected and will be used by NOAA to update and adjust requirements as may be necessary. Any comments or recommendations concerning the design of the Basic Data Set should be directed to:

Mr. Daniel J. Cotter, Director
User Affairs Division, Sx32
NOAA/NESS
Federal Building 4, Mail Stop D
Washington, D.C. 20233

At the present time, NOAA is using an "interim" Basic Data Set which provides for coverage of the entire United States (including Alaska, Hawaii, and Puerto Rico) every 16 days■

THEMATIC MAPPER ACCESSION AIDS

To aid users in selecting imagery from the archive of available Landsat 4 thematic mapper (TM) data, EDC provides false-color-composite images in 35-mm slide format.

These accession aids can be useful in assessing cloud cover, areal extent, some aspects of image quality, and other characteristics of interest prior to placing an order. Priced at $4 per frame, they cost substantially less than the lowest-priced standard products that can be obtained (241-mm paper prints presently start at $30).

The 35-mm TM accession aids are indexed by WRS path and row and are available for all scenes that have been received at EDC to date. They are suitable for projection use only and are not of a quality that would permit the generation of secondary products. Further information concerning these reference images can be obtained by contacting the TM coordinator at the following addresss:

NOAA Landsat Customer Services
EROS Data Center
Sioux Falls, SD 57198
Telephone: (605) 594-6159
FTS: 784-7159

THEMATIC MAPPER CCT'S

Limited quantities of Landsat 4 TM engineering data are available in digital form as computer-compatible tapes (CCT's). The CCT's are produced at a density of either 1600 or 6250 bits per inch, are in band-sequential format, and are available for fully processed (radiometrically and geometrically corrected) data only. The Space Oblique Mercator (SOM) pro-

jection is used on all.

Users should be aware that an unusually large blocking factor has been employed in creating the image data files on these CCT's. The image data are blocked four scan lines per record, resulting in a record size of 28,672 bytes. If this blocking factor is found to render the data unusable for any reason, EDC's Computer Services Branch would appreciate your comments, in writing, at the following address:

Computer Services Branch
Attn: Mr. Lyndon Oleson
EROS Data Center
Sioux Falls, SD 57198

LANDSAT 4 CCT SAMPLES OFFERED

Two packages of sample CCT data are available to users who may be developing and testing software designed to process Landsat 4 data in digital form.

MSS Sample Data

One package being offered includes a Landsat 4 MSS CCT, in all four bands, in the new VERSION 1 format. The VERSION 1 format was introduced last summer when Landsat 4 was launched. It reflects the international standards agreed to by the Landsat Ground Station Operators Working Group (LGSOWG). Announcements concerning its implementation appeared in both the July 1982 and September 1982 issues of this newsletter (Nos. 23 and 24).

In addition to the CCT itself, this sample package contains a 241-mm negative film transparency of band 2, computer printouts of the histograms generated during digital processing, and a draft copy of the current VERSION 1 format specification. The complete package is available for $50.

TM Sample Data

The other set of sample data being offered includes a CCT of a full 7-band scene of TM data, provided in a temporary format being used by the NASA Goddard Space Flight Center during the first year of Landsat 4 operations.

This CCT, also, is accompanied by a 241-mm negative transparency (in this case, of band 7), all pertinent computer listings, and format documentation. It is available for $200.

A table describing the data to be found on these tapes is presented below. When ordering, please specify whether the TM or the MSS sample package is desired, and indicate the packing density preferred (1600 bpi or 6250 bpi). Orders may be placed with:

NOAA Landsat Customer Services
EROS Data Center
Sioux Falls, SD 57198
Telephone: (605) 594-6151
FTS: 784-7151.

TM COLOR PRODUCTS, RESOLUTION, LOOK GOOD

Photoscientists at the EROS Data Center have been conducting a variety of experiments with the limited amounts of Landsat 4 thematic mapper (TM) data that have been received so far. One result of their efforts has been the assembly of a montage eight photographs (shown on the following two pages) which provide a quick visual comparison of TM imagery with other examples of remotely sensed data. These images were extracted and enhanced especially for presentation in the Landsat Data Users NOTES. The full-scene frames from which they were taken are in the EDC image archive and can be ordered using the scene ID information provided in the legend at the top of the display.

Readers will note that one of the TM images is a **natural-color** composite—a type of product which EDC has not been able to produce from Landsat data before now. Such an image product is possible because it incorporates TM band 1, sensed in the 0.45-0.52 μm (blue-green) region of the spectrum. The visible green and red hues making up the rest of the image are obtained by compositing TM bands 2 and 3, which cover the 0.52-0.60 μm and 0.63-0.69 μm portions of the spectrum, respectively. A **false-color** composite TM image is also shown, made from bands 1,3, and 4 (band 4 is the near-infrared band, with a spectral response from 0.76-0.90 μm). It approximates the color rendition of the standard MSS false-color composite immediately to the right of it and of the color-infrared aircraft photo just above.

The other images shown are black-and-white products generated using single-band data from the same scenes. All of these photos have been reproduced at the same scale (approximately 1:120,000) and were acquired at approximately the same time of year (July-August). The coverage area is that surrounding the Wayne County Metropolitan Airport, near Detroit, Mich.

In these images, ½ inch (1.27 cm) measured on the image is equivalent to about 1 mile (1.6 km) on the ground. The main runways at the airport are thus about 2 miles (3.2 km) long.

The TM data shown were digitally resampled,[1] using a cubic convolution resampling technique, to a pixel size representing 28.5 m on the ground prior to conversion to film. By comparison, the resampled ground pixel size is 57 meters square for the MSS data shown and 19 meters square for the RBV data. The corresponding level of detail, or ground resolution, evident in the TM data is so much greater than that obtained by the MSS that one initially tends to compare it with the detail of the aircraft or RBV images. (Readers should be aware that all photos were screened for offset printing. The continuous-tone original film images show even greater differences in detail and color saturation.)

Although years of work remain in

[1] Resampling of these data was done at NASA's Goddard Space Flight Center.

SAMPLE CCT CHARACTERISTICS

	MSS	TM
Satellite:	Landsat 4	Landsat 4
Sensor:	MSS (bands 1-4)	TM (bands 1-7)
Scene ID:	84008717302X0	84004916273X0
Path-Row:	037-034	027-033
Date of Acquisition:	October 11, 1982	September 3, 1982
Format:	Band sequential (BSQ)	Band sequential (BSQ)
	Band interleaved by line (BIL)	
Corrections:	Radiometric/Geometric	Radiometric/Geometric
Resampling:	Cubic convolution	Cubic convolution
Projection:	Space Oblique Mercator	Space Oblique Mercator
Density:	1600 bpi (two reels)	1600 bpi (seven reels)
	6250 bpi (one reel)	6250 bpi (three reels)

the effort to fully characterize the TM data being acquired by Landsat 4, informal comparisons such as this one are very encouraging. Apart from the benefits of greater spatial resolution, users will find the TM data to be of additional value in terms of their narrower spectral response and greater number of spectral bands. Applications scientists are now beginning to explore the many ways of combining the various bands to form composite images that reveal agricultural and geological differences with unprecedented detail■

LANDSAT 4 MSS DATA: STATUS REPORT

The band 4 decompression problem discussed in a previous issue of this newsletter (No. 24, p. 10) has been corrected. NASA's Goddard Space Flight Center implemented a modification to its ground processing system on October 23, 1982, which now accomplishes the decompression of MSS band 4 data from 64 brightness values to 128 brightness values. The latter range is standard for MSS data and is normally provided during the radiometric correction process at Goddard. This action resolved a problem that had been occurring with Landsat 4 MSS data processed prior to October 23, 1982. Reprocessing of those data is not planned.

An error in the computation of Space Oblique Mercator (SOM) projection parameters has resulted in the mislocation of SOM tick marks in Landsat 4 MSS data processed at Goddard prior to October 3, 1982. The error affected not only the SOM tick marks but the geodetic (latitude/longitude) tick marks as well. It additionally caused the image orientation angle provided on digital tapes of SOM-projected data to be in error. The internal geometric accuracy of these image data, however, was not affected. The problem was corrected at Goddard on October 3 and has not recurred.

Between September 16 and November 4, a data shift problem was noted during geometric correction of Landsat 4 MSS imagery by the EROS Digital Image Processing System (EDIPS). All scenes processed were affected, although in varying degrees. The problem involved a horizontal shift of image data by anywhere from 1-40 pixels to the left in each scan line of a given scene. This had no effect on the overall geometric or radiometric quality of the images themselves, but the shift did result in an inconsistency in the locations of the SOM and geodetic tick marks with respect to the image area. When visible (as it is in about 50 percent of the scenes processed) the data shift is manifested as a narrow white line running parallel to the right side of the image. Modifications to EDIPS to correct this problem were completed on November 4, 1982. Reprocessing of the pre-November 4 data is not planned■

LANDSAT DATA NOW AVAILABLE ON FLOPPY DISK

Landsat multispectral scanner (MSS) digital products are now available on floppy disk.

These products were developed in conjunction with a demonstration project conducted at the EROS Data Center which was aimed at defining the characteristics of a microprocessor-based image processing system. Because of the advantages offered by floppy disks in terms of availability, cost, and simplicity of associated hardware, it was decided to make Landsat MSS digital data available on this medium to the user public.

The ground area represented on one of these "floppies" is significantly smaller than that contained on a standard computer-compatible tape (CCT). Users must therefore select a specific subscene of interest (a 7½-minute quad, approximately) from a full MSS scene prior to ordering data in floppy disk form. All four spectral bands of the selected subscene are provided in band-interleaved-by-pixel format, just as on an X-format CCT,[a] in a form readable by CP/M-compatible microprocessor operating systems.

Specifications

The Landsat floppy disk products are single-sided, single-density, CP/M-compatible, 8-inch flexible diskettes equivalent to IBM Part No. 2305830. The following formatting specifications apply:

Density:	3200 bits per inch
Type Sector:	Soft sector
Bytes per Sector:	128
No. Sectors/Track:	26
No. Tracks:	77
No. Sides:	1

Two types of Landsat MSS data are available on floppy disk, each distinguished by the relative geometric accuracy of the image data provided. One is a system-corrected data product, and the other is a precision-corrected product. These products are available only for Landsat MSS scenes acquired after February 1, 1979.

System-Corrected Data

The system-corrected data product is of lower geometric accuracy than the precision-corrected product. The allowable error is less than or equal to 60 pixels, which is comparable to that of standard CCT products.

When ordering a system-corrected floppy disk, the user must identify his area of interest on a special grid which is overlaid on a 1:1,000,000-scale photographic print of the full MSS scene from which his product will be derived. The grid is a rectangular coordinate system defining 100-pixel increments in both the X-axis and Y-axis directions. The user defines a matrix on this grid no larger than 256 by 240 pixels (X and Y), and then labels the upper left corner of the matrix with the grid coordinates describing that location (scan line and pixel number). This same portion of the 1:1,000,000-scale print, as identified by the user, will be located on the appropriate archival CCT and subsequently written to disk.

The cost of a system-corrected floppy disk, consisting of a 256- by 240-pixel matrix in all four MSS bands (if available), is $100 for the first disk. Additional disks of any other area in the same scene and ordered at the same time are $30 per disk. Extra copies of each disk ordered at this time are also $30 each. Single-band, 1:1,000,000-scale, black-and-white Landsat prints (full scene) are available at $30 each. The transparent grid used for identifying the data matrix is available for $10.

Precision-Corrected Data

The precision-corrected data product is one that has been resampled to a 2-arc-second pixel format and that can be geographically referenced to a U.S. Geological Survey 7½-minute map quadrangle. Because of the stringent ground control requirements needed for this resampling, this option is available only for certain scenes acquired after February 1, 1979, that have been subjected to special processing based on the locations of known map control points. Errors of less than or equal to 20 pixels (down to 1 pixel) can be obtained, depending on the number of map control points used.

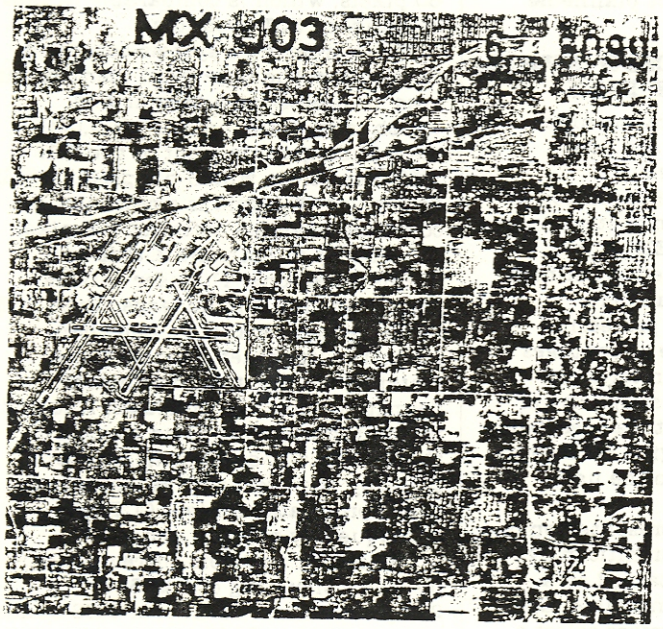
Precision-corrected subscenes are identified by the user in the same way that subscenes of system-corrected data are identified. The matrix defined, however, can be no larger than 226 by 226 pixels (X and Y axes).

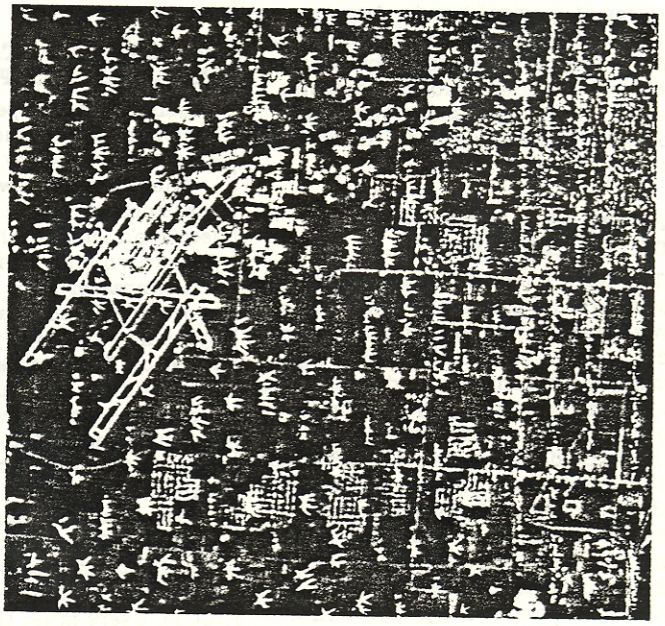
Precision-corrected data products

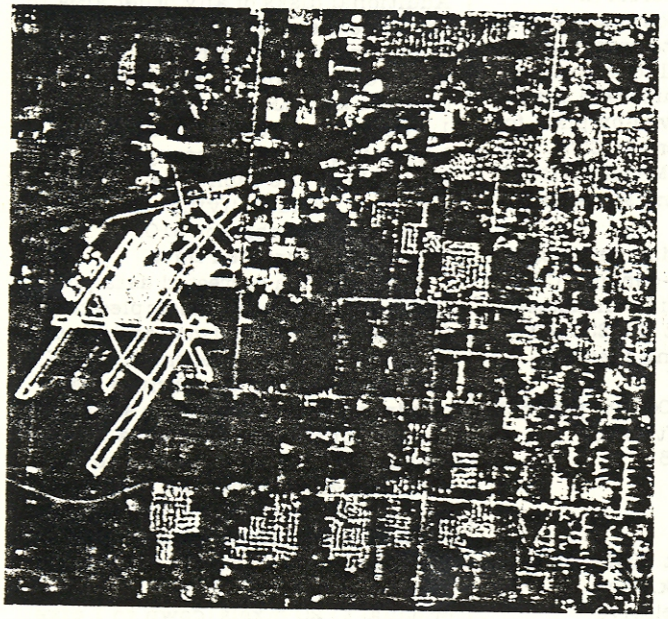
Continued on page 3

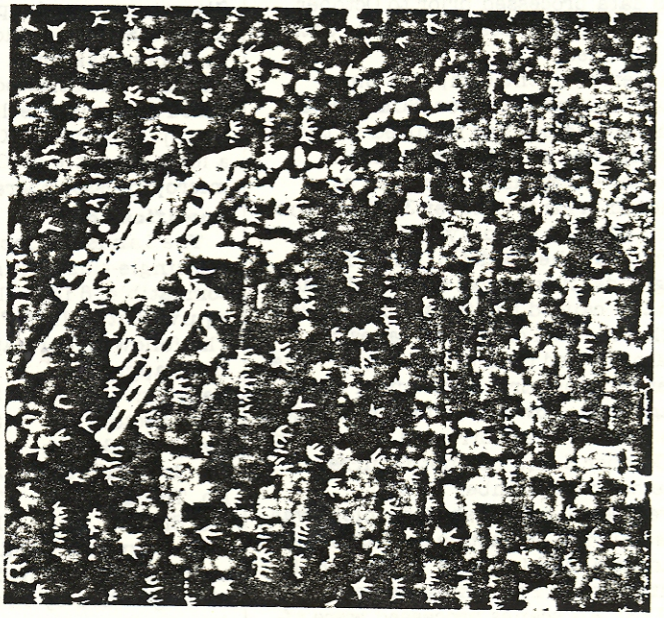
[a] "X-format" refers to the band-interleaved-by-pixel (BIP) format used in the production of CCT's prior to February 1, 1979, when EDC commenced its digital image production operations. Landsat data produced on CCT's after that date have been in band-sequential (BSQ) or band-interleaved-by-line (BIL) format

THEMATIC MAPPER IMAGE COMPARISONS









Top left—High-altitude aircraft photo, color-infrared film. Scene ID: 61030006B6093, Frame: 6099.

Bottom left—Landsat 4 thematic mapper false-color composite image, produced from bands 1,3, and 4. Scene ID: E-1440-99TM.

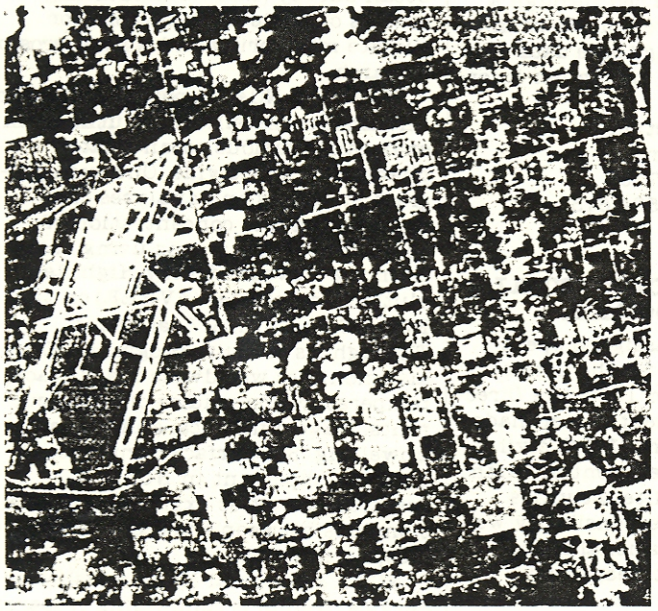
Top right—Landsat 4 thematic mapper natural-color composite image, produced from bands 1,2, and 3. Scene ID: E-1439-99TM.

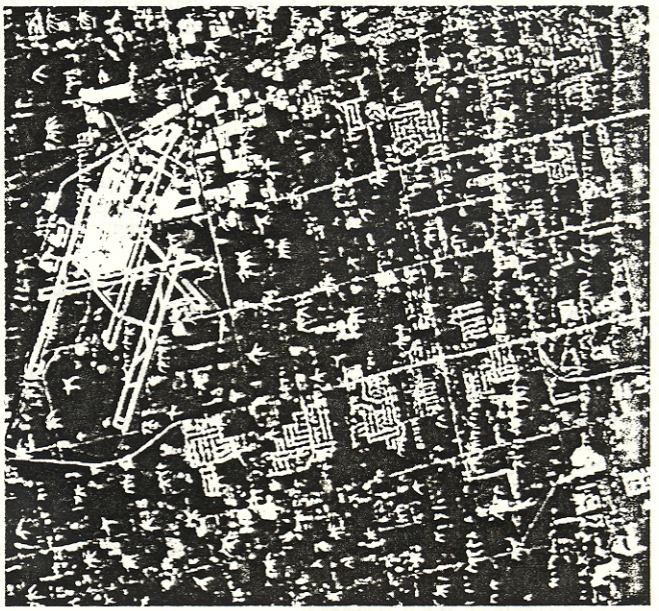
Bottom right—Landsat 3 multispectral scanner false-color composite image, produced from bands 4,3 and 7. Scene ID: E-1438-99TM.

The data shown on these two pages were extracted from larger, full-size images bearing the following scene ID numbers in the Landsat archive:

Thematic mapper scene	4009-15413
Multispectral scanner scene	83050015352X0
Return-beam vidicon scene	83122015315XA
Aircraft scene	6103000636093-6009

The E-series scene ID's given in the captions below should be used to order only the subscenes shown here.





Top left—Landsat 3 return-beam vidicon image, sensed in the 0.51 μm to 0.75 μm range. Scene ID: E-1437-99TM.

Bottom left—Landsat 3 multispectral scanner image, band 5. Scene ID: E-1438-99TM.

Top right—Landsat 4 thematic mapper image, band 3. Scene ID: E-1439-99TM.

Bottom right—Landsat 4 thematic mapper image, band 4. Scene ID: E-1440-99TM.

Continued from page 5.

are $600 for the first disk and $30 for each duplicate disk or additional disk of other areas ordered at the same time from the same scene. Once an order for arc-second data has been received and a transformation tape has been produced for the scene, the tape will be archived. Any subsequent orders for precision-corrected disks produced from these archived data will cost $100 for the first and $30 for each additional disk.

Sample Disks

Three sets of sample data, all precision-corrected , are available on floppy disk for users who wish to assess their hardware capability before ordering. These data are of the Black Hills of South Dakota; St. Paul, Minnesota; and Albany, New York. They are available for $30 each.

Any questions concerning this new line of standard Landsat products may be directed to:

NOAA Landsat Customer Services
EROS Data Center
Sioux Falls, SD 57198
Telephone: (605) 594-6151
FTS: 784-7151

WORLD BANK OFFERING LANDSAT MAPS

The World Bank is now making some of its Landsat and thematic maps available through International Mapping Unlimited (IMU), its U.S. map distribution agent. Countrywide Landsat maps exist for Nepal, Bhutan, and Bangladesh, as do mosaics for portions of India, Burma, and Peru. Each map sheet is $10 plus postage and handling. The scales of the maps range from 1:1,000,000 to 1:100,000. All Landsat scenes are edge-enhanced or computer-categorized, and manually mosaicked, with city/town and infrastructure annotations added. A free listing describing 20 of these map sheets can be obtained by writing to: International Mapping Unlimited (IMU), 4343 39th Street, N.W., Washington, D.C. 20016.

AVAILABLE: RADAR IMAGES OF NEW JERSEY

The EROS Data Center has received a quantity of side-looking airborne radar (SLAR) imagery taken over the State of New Jersey. Acquired under a U.S. Geological Survey contract, these synthetic-aperture SLAR images cover an area approximately 64 km wide by 208 km long, extending from the lower New York Bay to the Delaware Bay. Thirteen strips of coverage (representing flight lines) were acquired, one looking to the southeast and the remaining twelve looking to the northeast. Both near- and far-range images, with a 5- to 10-percent sidelap between the two, were obtained in all coverage acquired.

These 1:400,000-scale SLAR strip images have been plotted on base maps of 1:1,000,000 scale and are geographically referenced through a manual microfiche system. Users interested in purchasing these data may contact the following for further information:

User Services Section
EROS Data Center
Sioux Falls, SD 57198
Telephone: (605) 594-6151.
FTS: 784-7151

NOAA'S ENVIRONMENTAL SATELLITE PROGRAM

When NOAA was assigned operational responsibility for the Landsat program in November 1979, the Directive issued by President Carter made NOAA responsible for **all** U.S. civil operational (non-experimental) Earth remote sensing satellite activities. This assignment of responsibility was reconfirmed in the national space policy that President Reagan announced on July 4, 1982. NOAA's program responsibilities therefore include not only land remote sensing, but continued control over the many ocean, atmosphere, and near-space remote sensing platforms of various types that have been operational for years.

The following is a summary of some of the research and operational monitoring projects that NOAA has been engaged in to examine global environmental phenomena. These efforts have included international cooperation as well as national programs, and the information obtained has been used to form a very substantial existing data base.

Oceans

In the area of ocean monitoring, NOAA's Marine Pollution Assessment Program provides scientific information that can be used to minimize the adverse consequences of marine waste disposal and accidental discharge of hazardous substances in our oceans. NOAA contributes its findings to various international organizations and studies. Through NOAA, the U.S. participates in the Global Investigation of Pollution in the Marine Environment (GIPME)—a program established by UNESCO's Inter-Government Oceanographic Commission. GIPME provides a continuing assessment of the health of the oceans through regional programs and the development of uniform analytic and data management methodologies. The primary focus of the program is to establish the relationship between marine pollution and its effects on ocean organisms and man. NOAA provides technical support for the program and facilities that serve as the regional management center for pollution data. Additionally, the National Ocean Survey (NOS) is conducting studies of sea-level variations for climate monitoring and coastal erosion research.

Data from NOAA's polar-orbiting environmental satellites are utilized in examining various ocean-related phenomena worldwide. One such program measures and analyzes the distribution and concentration of aerosols over the oceans using data from the Advanced Very High Resolution Radiometer (AVHRR) on the NOAA-6 and NOAA-7 satellites. Through its satellite program, NOAA also monitors worldwide sea surface temperature for studies of ocean currents, wave dynamics, and ocean upwelling. Sea surface temperature data are important in NOAA's research activities examining the relationships between the ocean and atmospheric events.

NOAA's National Marine Fisheries Service (NMFS) is conducting research on the distribution and abundance of contaminants in estuarine, coastal, and shelf waters. Data from these efforts are used to measure the biological effects of contaminants on living marine resources. NOAA's activities in this area are coordinated with those of other nations through the Marine Environmental Quality Committee of the International Council for the Exploration of the Sea.

Atmosphere

The study of the Earth's atmosphere involves numerous programs conducted by NOAA. The National Earth Satellite Service (NESS) is monitoring the stratosphere using satellite data to evaluate, develop, and implement specific systems for measuring the composition of this layer of the atmosphere. This program includes the establishment of a satellite-based operational ozone monitoring system.

NOAA's satellite and ground based stratospheric ozone programs are part of the World Meteorological Organization's Global Ozone Monitoring Network. This international program examines the impact of halocarbon emissions on the ozone layer, acquires information on the ozone's global variability and vertical distribution, and provides information to national and international agencies for the protection of the public health and welfare.

In 1979, the World Meteorological Organization established the World Climate Program. This program is designed to organize studies of climatic changes and their impacts on the natural environment and world food supply and to plan and execute an integrated international study of climate change and variability. For its part, NOAA provides satellite and ground measurements to be used in: ocean-atmospheric interaction studies, equatorial Pacific Ocean climate studies, studies of the long-term effects of man-induced and natural changes on the climate, and determination of the effect of cloud cover on the Earth's radiation balance.

The EARTHWATCH, or Global Environment Monitoring System, was organized in the early 1970's by the United Nations Environment Program. This project is an international effort to coordinate various activities used in monitoring the Earth, to acquire data needed for the rational management of the environment, and to track and assess environmental trends. In support of this program, NOAA provides a network for world monitoring of carbon dioxide, a system for ozone monitoring, air quality and acid rain monitoring, snow cover assessment, ocean monitoring, and sea ice monitoring.

NOAA's National Weather Service (NWS) participates in the World Meteorological Organization's global meteorological program—called the World Weather Watch. The World Weather Watch is a global observing system that obtains and disseminates surface, marine, upper air, radar, and satellite observations of the atmosphere and oceans to serve as the foundation for weather forecasts, storm warnings, and environmental quality assessments worldwide. NOAA not only aggregates and disseminates global satellite and ground-based observations but also provides facilities for the World Meteorological Center in Washington, D.C.

Through a program of international data exchange, NOAA's Environmental Data and Information Service (EDIS) aggregates and disseminates global ocean, atmosphere, solid Earth, and solar-terrestrial data and data products used worldwide in research concerning the physical environment and its interactive processes. Additionally, EDIS, based on these aggregated data, produces and disseminates global asessments of the impact of natural or man-induced environmental changes on food production, energy demand, water resources, health and welfare, and commerce.

Land

The study of the Earth's land masses is one that involves numerous activities. NOAA's National Geodetic Survey (NGS) is currently working with the Federal Republic of Germany in a bilateral program known as the International Radio Interferometric Surveying Project. The primary objective of this project is to improve the monitoring of polar motion and Earth rotation and to measure changes between the North American and European plates. Improved geodetic monitoring systems will contribute significantly to understanding of the dynamics of the Earth's atmosphere, ocean, and land masses. Further geodetic studies are also being conducted using satellite data to monitor the Earth's crustal motion.

Land and water resources are being regularly monitored on a worldwide basis using satellite and ground measurements. NOAA participates in UNESCO's International Hydrological Program and the World Meteorological Organization's Hydrology and Water Resources Program. NOAA hydrologists provide data for world water resources management, the development of methods and techniques for water resources management, and an improved understanding of the interrelationship between human activities and the world hydrological system.

Using satellite data, NOAA regularly monitors significant climate changes for agriculturally important regions of the world. Data from the NOAA polar-orbiting satellites are used to develop daily surface insolation estimates, precipitation estimates, and global vegetation index products. NOAA satellite data are also used to develop global snow cover and climatology maps and to measure and analyze the Earth's radiation budget and global cloud cover.

NOAA's global monitoring activities are indeed diverse, and they represent an extensive study of the Earth's environment as part of the international effort to better understand our world.

UNISPACE 82

The Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 82) was held August 9-21, 1982, in Vienna, Austria. The purpose of UNISPACE 82 was to discuss examples of the peaceful uses of space technology and the practical benefits of such activities to the nations of the world. Representatives from the U.S. government and industry participated fully in this conference, demonstrating the important role of the U.S. in the development and application of space technology.

Approximately 170,000 people viewed the U.S. exhibit. Active demonstrations of U.S. space technology were presented in areas such as satellite communications, photovoltaic-powered equipment, and meteorological remote sensing. The U.S. also presented several proposals relating to space technology as UNISPACE 82 initiatives.

A number of different activities concerning the Landsat program were well received at the conference. Representatives from U.S. industry presented a demonstration featuring inexpensive Landsat image analysis microprocessors. NASA sponsored a technical presentation on the recently launched Landsat 4 satellite and its new thematic mapper instrument. Special indexes listing high-quality Landsat scenes available from the EROS Data Center were also distributed to each delegation at the conference. Finally, NOAA, in cooperation with the Austrian Academy of Sciences, presented a joint exhibit demonstrating the practical applications of Landsat data■

LANDSAT 4 SYMPOSIUM

The NASA Goddard Space Flight Center, Landsat 4 Science Office, has invited the public to attend a **Landsat 4 Early Results Symposium,** to be held February 22-24, 1983, at the Goddard Space Flight Center in Greenbelt, Md. The sessions will include discussions in the following program areas:

- Radiometry:
  - -Sensor and Spacecraft Performance
  - -Image Data Quality
- Geometry
  - -Sensor and Spacecraft Performance
  - -Image Data Quality
- Applications Information
  - -Renewable Resources Management
  - -Non-Renewable Resources Management
  - -Planning/Environmental Management

For further information and registration procedures, please contact:

Judi Abraham
c/o ORI, Inc.
1400 Spring Street
Silver Spring, MD 20910
Telephone: (301) 495-6071.

AVHRR DATA BEING USED IN WILDFIRE MANAGEMENT

A cooperative project by the EROS Office, the Bureau of Land Management (BLM), and NOAA was begun earlier this year to evaluate the utility of Advanced Very High Resolution Radiometer (AVHRR) data for monitoring areas of herbaceous vegetation.

AVHRR data are being evaluated in a time-series analysis to demonstrate their potential for monitoring vegetation throughout its growth cycle and estimating fire fuel conditions and loadings. The BLM requires these estimates as part of its fire management program.

The AVHRR is a multispectral sensor carried aboard the NOAA-series polar-orbiting satellites. AVHRR data have a nominal ground resolution of 1.1 km and cover a swath width of 2,400 km. The visible data (0.58-0.68 μm) in band 1 and the reflected infrared data (0.76-1.1 μm) in band 2 can be used to compute a greenness index, or Normalized Difference (ND). The ND is computed by subtracting band 1 from 2 and then dividing the result by the sum of band 1 and band 2:

$$ND = \frac{\text{Band 2} - \text{Band 1}}{\text{Band 2} + \text{Band 1}}$$

Large ND values represent areas containing high proportions of standing green biomass.

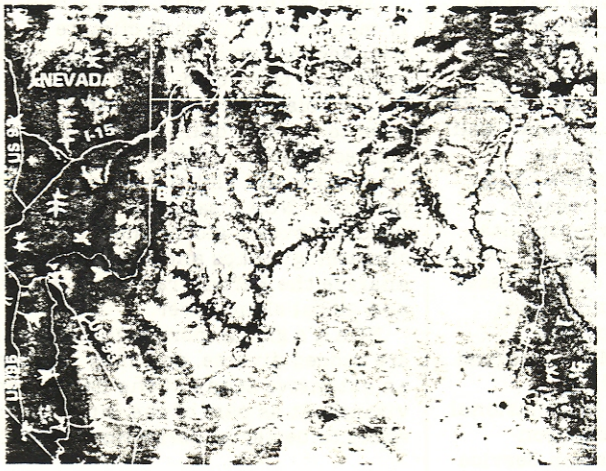
In March and April of 1982, AVHRR images were acquired for northwestern Arizona and registered to a geographic data base containing roads and state boundaries. The images covered the spring growth cycle (from dormancy through senescence) of the annuals in this area. ND values were computed from AVHRR data for five dates and analyzed by BLM personnel to determine their usefulness in supporting wildfire management decisions. Two such computed images are shown on this page (Fig. 1 & 2).

It appears that AVHRR data can be a valuable input to the BLM's Wildfire Initial Attack Management System. Preliminary investigations have shown that AVHRR data can be used to estimate the time at which senescence begins, to document the relative amounts of standing green biomass, and to follow the seasonal growth of annual grasses (illustrated in the accompanying chart, Fig. 3. These data also show potential for use in national or global vegetation monitoring, assessment, and management programs.

Those interested in obtaining AVHRR data may contact:

Satellite Data Services Division
NOAA/Environmental Data Information Services
World Weather Building, Room 100
Washington, D.C. 20233
Telephone: (301) 763-8111.

April 7



April 29

Figures 1 & 2.—Normalized Difference (ND) images of northwestern Arizona prepared from NOAA-6 AVHRR data acquired in April 1982. Lighter tones indicate higher levels of green vegetation. Sites A,B, and C were intensely monitored on the ground by Bureau of Land Management personnel and were the source of the measurements presented in Fig. 3.

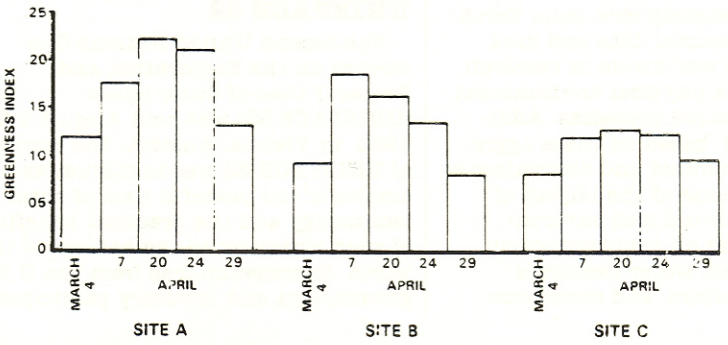


Figure 3.—Normalized Difference (ND) computed from NOAA-6 AVHRR data collected during March and April 1982 over three sites in northwestern Arizona (see Fig. 1 & 2). Using this chart, Bureau of Land Management personnel can estimate the onset of senescence of annual vegetation and evaluate the seasonal variation of herbaceous cover from site to site.

SYMPOSIA

The **18th Canadian Symposium on Remote Sensing,** sponsored jointly by the Canadian Remote Sensing Society and the Association Quebecoise de Teledetection, will be held May 3-6, 1983, in Montreal, Quebec. The general theme of this year's meeting will be the integration of remote sensing into resource management. A special session will be devoted to simulation of data from new and planned satellites such as Landsat 4, SPOT, and Radarsat. Additional information regarding this symposium may be obtained by contacting: Mr. Robert Desjardins, Department de geographie, Universite de Quebec a Montreal, B.P. 8888, Succ A, Montreal, Quebec H3C 3P8, Canada. Telephone: (514) 282-4107.

The **17th International Symposium on Remote Sensing of Environment,** to be held May 9-13, 1983, in Ann Arbor, Mich., will address state-of-the-art capabilities and effective application of remote sensing technology. Sponsored by the Environmental Research Institute of Michigan, both conventional sessions and multidisciplinary poster sessions will be held. The call for papers solicited recent research results on ultraviolet, infrared, microwave, acoustic, seismic, and other types of sensors, either singly or in combination.

Contributors and other persons interested in attending this meeting may contact the Remote Sensing Center, Environmental Research Institute of Michigan, P.O. Box 8618, Ann Arbor, MI 48107. Telephone: (313) 994-1300.

The American Society of Photogrammetry, in cooperation with the Renewable Natural Resources Foundation (RNRF) and its member societies, will sponsor the **RNRF Symposium on the Applications of Remote Sensing to Resource Management,** to be held next May 22-27, 1983, in Seattle, Wash. The intent of this symposium is to bring the basic technology of remote sensing to resource managers and technicians. Topics of interest will include remote sensing applications to forestry, wildlife, rangeland, recreation, environmental monitoring, vegetation damage, land use classification, and water resources. A special session on the legal aspects of remote sensing and a field trip to Mount St. Helens are planned. Proposals for poster papers and/or queries concerning how to register for this symposium may be addressd to: Dr. Peter A. Murtha, RNRF Symposium Program Chairman, Faculty of Forestry, University of British Columbia, Vancouver, B.C. V6T 1W5, Canada.

A special emphasis on resource evaluation will be the theme at the **9th International Symposium on Machine Processing of Remotely Sensed Data,** to be held June 21-23, 1983, in West Lafayette, Ind. The meeting is one of a series that has been sponsored every year by Purdue University's Laboratory for Applications of Remote Sensing (LARS). The call for papers solicited research results in such topical areas as scene simulation and modeling, geometric and radiometric preprocessing of data, stratification and sampling, classification algorithms, and digital geographic information systems. Those wishing to attend are invited to contact Mr. D. B. Morrison, Symposium Coordinator, Purdue University/LARS, 1220 Potter Drive, West Lafayette, IN 47906. Telephone: (317) 494-6305. Inquiries regarding the technical content of the symposium can be directed to the Symposium Chairman, Dr. Richard A. Weismiller, at the same address.

Hamburg, Federal Republic of Germany, will be the site for an **International Symposium on Hydrological Applications of Remote Sensing and Remote Data Transmission,** to be held August 15-27, 1983. The symposium is sponsored by the International Association of Hydrological Sciences and is co-sponsored by the World Meteorological Organization. It will be one of a number of symposia to be convened as part of the XVIII General Assembly of the International Union of Geodesy and Geophysics. The sessions will cover such topics as precipitation, snow and ice, surface water, soil moisture, ground water, hydrogeology, and water resources planning and management. Requests for further information on this meeting may be sent to A. Ivan Johnson, President, International Committee on Remote Sensing and Data Transmission, Woodward-Clyde Consultants, Harlequin Plaza-North, 7600 East Orchard Rd., Englewood, CO 80111.

A symposium entitled **Renewable Resource Inventories for Monitoring Changes and Trends** will be hosted by Oregon State University's School of Forestry August 15-19, 1983, in Corvallis, Oregon. Current capabilities to inventory, monitor, and predict trends of renewable resources, especially in regard to wildland resources, will be assessed during the series of concurrent sessions. Further details may be obtained from the symposium's General Chairman, John F. Bell, care of the School of Forestry, Oregon State University, Corvallis, OR 97331.

The **1983 IEEE International Geoscience and Remote Sensing Symposium (IGARSS'83)** will be held at the Hilton Hotel in San Francisco, Calif., August 31-September 2, 1983. This meeting is being sponsored by the Institute of Electrical and Electronics Engineers (IEEE) and is cosponsored by NASA, NOAA, the European Space Agency (ESA), the European Association of Remote Sensing Laboratories (EARSeL), the Deutsche Forschunge -und Versuchsanstalt fur Luft -und Raumfahrt d.V. (DFVLR), the European Association of Exploration Geophysicists, the Canadian Remote Sensing Society, and several other national and international organizations. It is being held jointly with the annual meeting of the International Union of Radio Science (URSI). Commission F on Propagation of Non-Ionized Media. The goal of IGARSS'83 is to enable participants to gain a general overview of the present status and future prospects of the geoscience disciplines and techniques of remote sensing. The principal focus of the URSI Commission F meeting will be the use of electromagnetic techniques for remote sensing. Registration information is available from Mr. Mike Buettner, Chairman of the Publicity Committee, Mail Stop L-156, Lawrence Livermore National Laboratories, P.O. Box 808. Livermore, CA 94550■

EDC TRAINING SCHEDULE

April 25 - May 27, 1983: International Workshop: Applications in Geologic and Hydrologic Exploration and Planning (Sioux Falls, S. Dak.) Open to non-U.S. scientists only. Contact: Office of International Geology, U.S. Geological Survey National Center (Mail Stop 917), Reston, VA 22092. Telephone: (703) 860-6418.

Sept. 12 - Oct. 14: International Workshop: Applications in Vegetation Assessment and Land Use Planning (Sioux Falls, S.Dak.) Open to non-U.S. scientists only. Contact: Office of International Geology, U.S. Geological Survey, National Center (Mail Stop 917), Reston, VA 22092. Telephone: (703) 860-6418.

ADDITIONAL TRAINING IN REMOTE SENSING

Jan. 3-7, 1983:
Remote Sensing for Soil Surveys and Resource Inventories (Brookings, S. Dak.) Contact: Nancy Dameron, Visiting International Scientist Program, Remote Sensing Institute, South Dakota State University, P.O. Box 507, Brookings, SD 57007. Telephone: (605) 688-4184.

Jan. 10-14:
Remote Sensing Resources Workshop (Tucson, Ariz.) Contact: Michael C. Parton, University of Arizona, Office of Arid Lands Studies, Arizona Remote Sensing Center, 845 North Park Avenue, Tucson, AZ 85719. Telephone: (602) 626-4925.

Feb. 7-11:
Aerial Photography/Aerial Photo Interpretation Workshop (Moscow, Idaho) Contact: Dr. Joseph J. Ulliman, College of Forestry, Wildlife, and Range Sciences, University of Idaho, Moscow, ID 83848. Telephone: (208) 885-7016.

Feb. 21-25:
Eleventh Alberta Remote Sensing Course (Edmonton, Alberta) Contact: Mr. Cal Bricker, Alberta Remote Sensing Center, 11th Floor, 9820 - 106th Street, Edmonton, Alberta T5K 2J6, Canada. Telephone: (403) 427-2381.

Mar. 21-25:
Remote Sensing for Geologists and Geophysicists (Fort Worth, Texas) Contact: Registrar, Goetz/Rowan Short Course, P.O. Box 7, Altadena, CA 91001.

June 12-17:
4th Geosat Workshop (Flagstaff, Ariz.) Contact: The Geosat Committee, 153 Kearny St., Suite 209, San Francisco, CA 94108. Telephone: (415) 981-6265.

LANDSAT 4 WRS INDEX OF U.S. NOW AVAILABLE

NOAA has recently updated the Landsat Worldwide Reference System (WRS) Index which had been a part of the "Preselected Coverage" order packet for Landsats 1,2, and 3, to include the path-row points for Landsat 4. The Landsat 4 WRS is similar to that which is used with Landsats 1,2, and 3 except that the spacing of the paths (running vertically) has been adjusted to accommodate 233 paths worldwide. Landsats 1,2, and 3 traversed 251 paths before commencing their repetitive swathing patterns.

This U.S. index map measures 46 cm by 54 cm. On its reverse side, a WRS index for Landsats 1,2, and 3 is provided of the same area.

This map may be obtained free of charge (while quantities last) by contacting:

NOAA Landsat Customer Services
EROS Data Center
Sioux Falls, SD 57198
Telephone: (605) 594-6151
FTS: 784-7151

EDC LANDSAT PRODUCTION STATISTICS

	Apr. '82		May '82		June '82		July '82		Aug. '82		Sept. '82		6-Month Total	
	MSS	RBV	MSS	RBV	MSS	RBV	MSS	RBV	MSS	RBV	MSS	RBV	MSS	RBV
Landsat scenes acquired (satellite acquisitions)*	2,504	626	2,158	544	1,960	391	3,094	463	1,609	538	2,388	442	13,933	3,054
Landsat MSS scenes/RBV subscenes received at EDC	1,847	1,744	1,562	1,711	2,540	2,147	3,133	2,009	1,324	1,096	1,643	1,823	12,054	10,329
Average time in days from EDC receipt to archive availability	9.7	6.9	8.0	8.3	18.6	30.9	16.1	26.1	10.7	36.5	10.4	22.3	—	—
Average delivery time in days from receipt of order at EDC to shipment:														
Standard photographic products	13		13		15		19		17		16		—	
Standard digital products	12		7		5		7		5		9		—	
Landsat photographic frames sold	9,076		7,385		6,118		13,637		19,272		5,485		60,973	
Landsat digital scenes sold	181		497		421		369		393		529		2,390	
TOTAL LANDSAT DOLLAR VOLUME	$213,641		$262,242		$236,231		$381,674		$353,463		$199,984		$1,647,225	

*Figures are revised periodically to reflect updated information received from NASA.

The Landsat Data Users Notes is published quarterly in order to present information of interest to the user community regarding Landsat products, systems, and related remote sensing developments. There is no subscription charge; individuals and organizations wishing to receive the Notes should contact: NOAA Landsat Customer Services, EROS Data Center, Sioux Falls, SD 57198, U.S.A., Telephone: (605) 594-6151, FTS: 784-7151.

Comments, corrections and queries of any kind may be directed to: Editor, Landsat Notes, EROS Data Center, Sioux Falls, SD 57198.

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